HISTORY

OF

THE UNITED STATES NAVAL RADIOLOGICAL DEFENSE LABORATORY

1959

A LABORATORY COMES OF AGE -- 1959

The first installment of the history of the U.S. Naval Radiological Defense Laboratory (1946 - 1958) of necessity began with a detailed account of its early struggles, its organizational problems and administrative decisions, leading gradually to its sine qua non, the Technical Program and the mounting accomplishments in radiological defense. The 1959 installment and subsequent ones, will reverse the procedure and plunge immediately into a description of the challenges faced and how they are being met.

ACHIEVEMENTS OUTSIDE THE LABORATORY

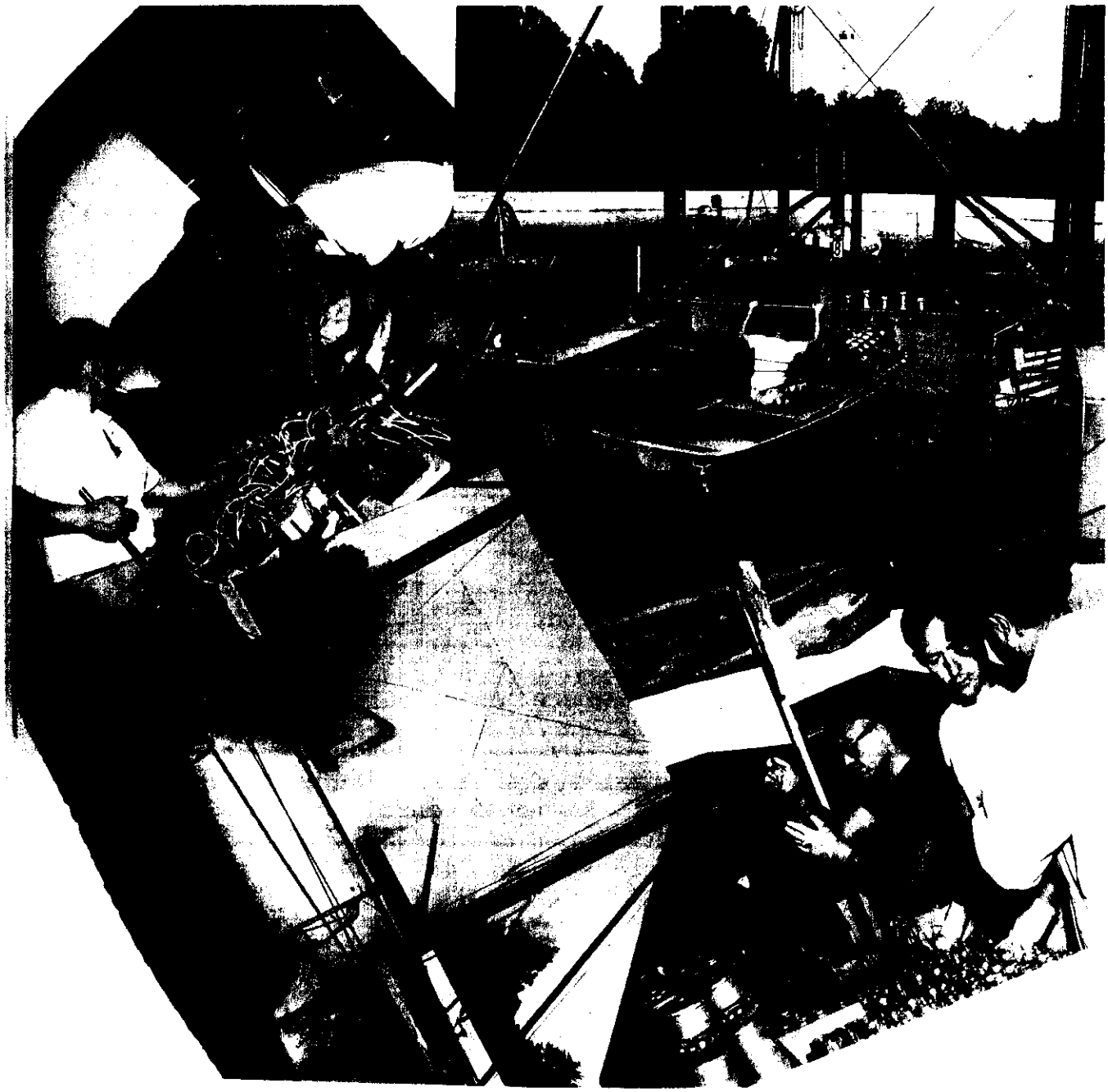
Field Tests

Major projects, conducted largely as field operations, included the HYDRA I, TARGET COMPLEX DECONTAMINATION, and FALLOUT SHELTER Programs.

The HYDRA Program, embracing a long range plan and involving laboratory studies as well as a series of underwater high explosive bursts, was initiated in 1958 when the President invited a ban on full scale nuclear tests. In March 1959, pre-test shots in the program were made in the Bay adjacent to the San Francisco Naval Shipyard to check the development of various instruments to be used in subsequent experiments. The purpose of this program, sponsored by the Bureau of Ships, is to determine the radiological effects of underwater nuclear detonations; this covers many facets of a combined theoretical-experimental program. High explosives with a radioactive tracer are used to simulate the detonation of a nuclear weapon and to follow the path taken by its products. The information sought concerns what takes place both above and beneath the surface of the water when a nuclear weapon, such as an atomic depth charge, is detonated beneath the surface. Ultimately the goal is the determination of the mechanisms of the explosion, the proportion of the

HYDRA I

(TOP)
(1) Preparation of sampling instruments
(2) Placement of explosive charge
(BOTTOM)
(3) The Shot
(4) Measurement of samples obtained



radioactivity produced that is absorbed in the sea, that which is released to the air, and measurement of the activity entering the base surge or remaining aloft in a radioactive cloud, so that equations can be established for predictions of radiological effects over a wide range of yields and depths of burst.

Early in April a dozen scientists from the Laboratory set up equipment for the first phase experiment (called HYDRA I) at the David Taylor Model Basin near Washington D. C. One-pound charges, some with and others without a radioactive tracer, were employed. Photographs were taken simultaneously of surface and sub-surface phenomena. To avoid any possible hazard connected with shots containing the radioactive tracer, radiological safety measures were set up to completely control possible contamination and radiation exposures.

After thirteen weeks, the field phase of HYDRA I was successfully completed, with a total of 197 shots fired in depths ranging from one foot five inches to eight feet, and some 50,000 feet of motion picture film developed. Work is continuing on data reduction and various analyses preparatory to publication of a technical report of the operation and the data obtained.

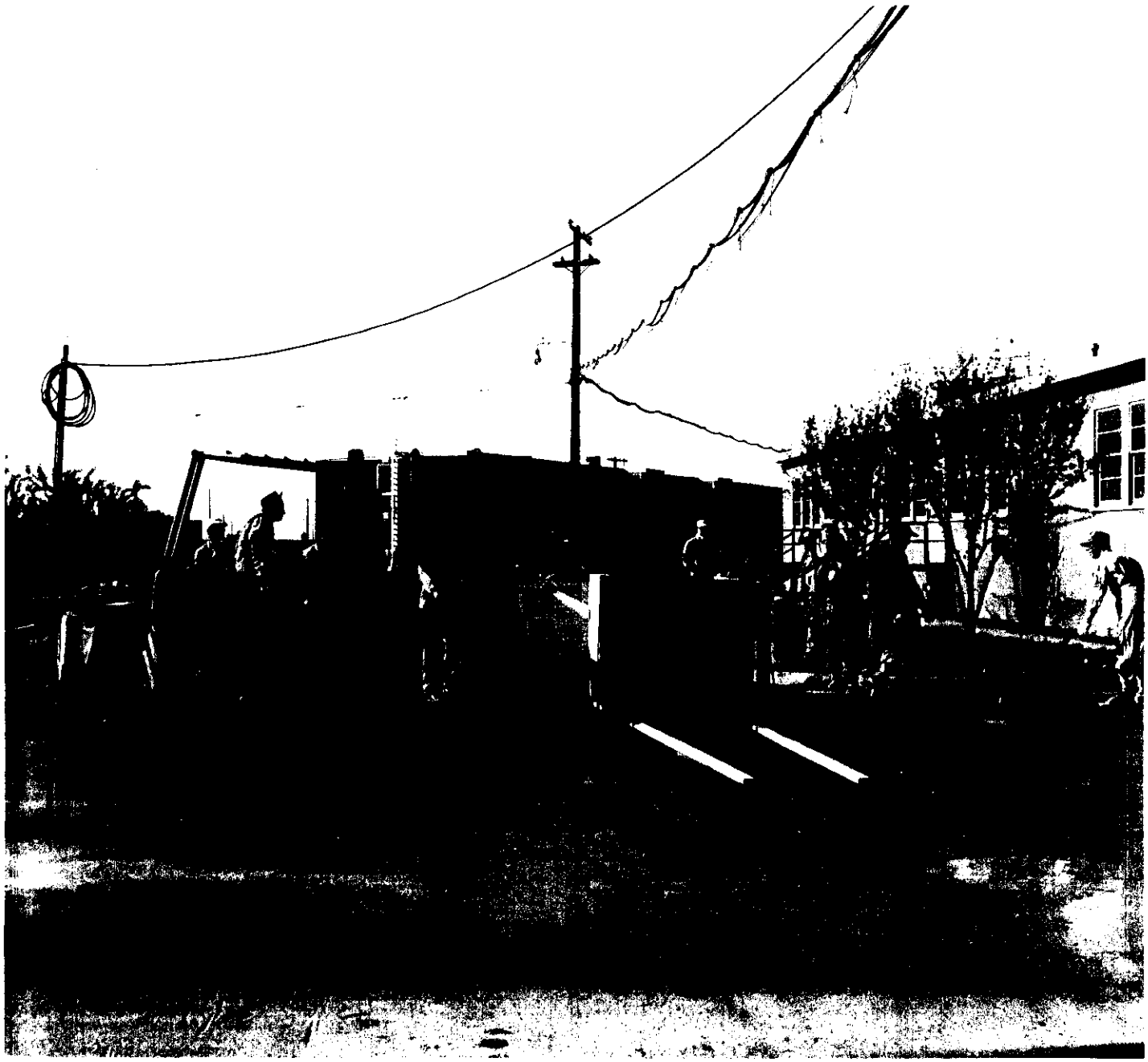
Experiments in Decontamination

In November the "Target Complex Decontamination Experiment," sponsored by the Office of Civil and Defense Mobilization (OCDM), was conducted at the Laboratory's Field Test Station at Camp Parks, an Army Base near Pleasanton, California. This test, an outgrowth of earlier versions performed in 1956 and 1958 at Camp Stoneman before that base was vacated by the Army, involved the spreading of radioisotope-tagged sand on four acres of a simulated village consisting of six buildings, streets, lawns, trees and shrubbery. The sand represented fallout that would be deposited if a one-megaton bomb had been detonated forty miles upwind in Marin County.

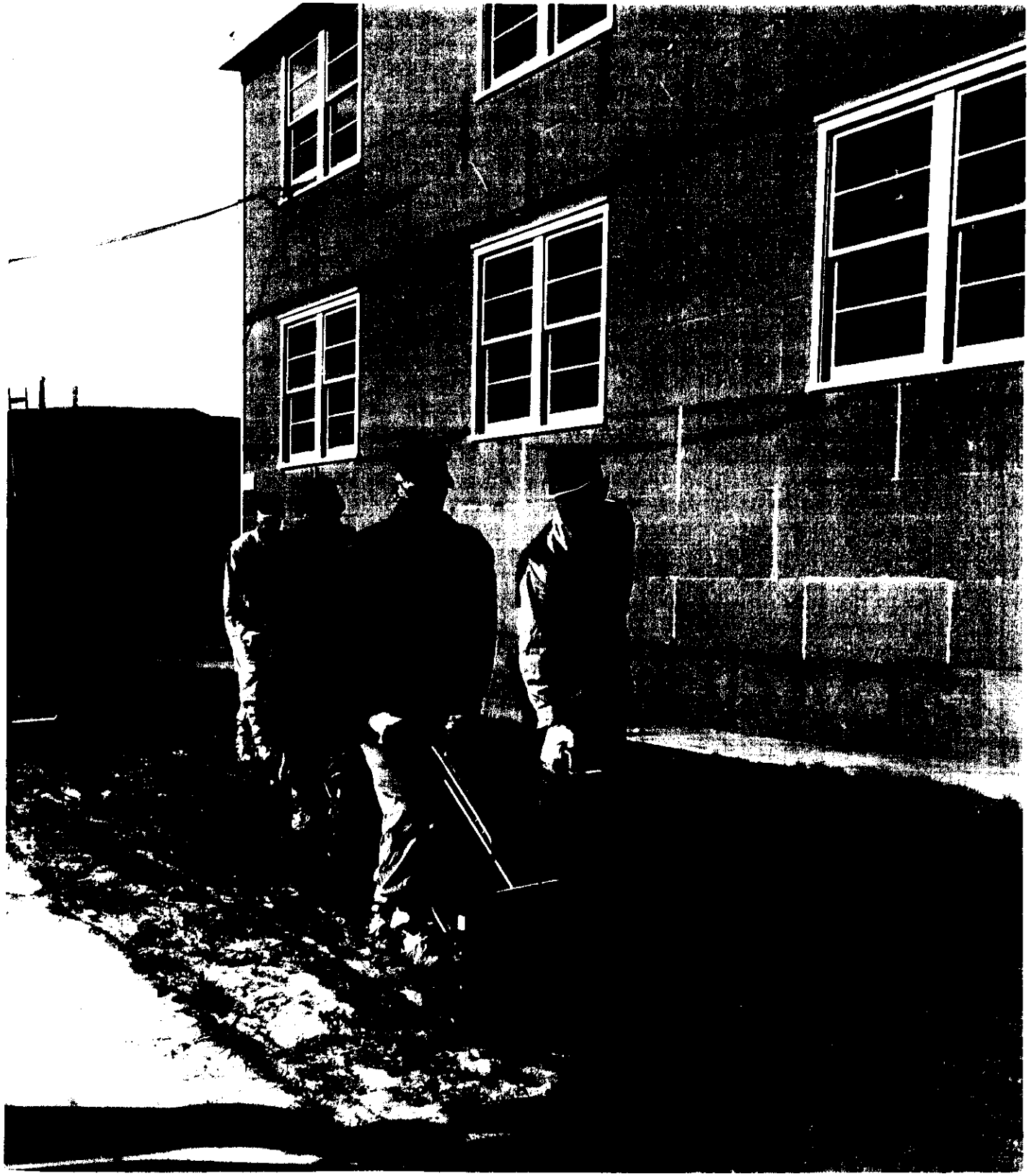
The area was left thus contaminated for ten days to equal the delay that would be required were it covered with real fallout, to observe the movement of particles by wind and possible rain, and to measure the resulting redistribution. "Decon" crews then entered the area to remove the contamination with various types of equipment such as vacuum sweepers, street flushers, fire hoses, plows, bulldozers, scrapers, etc., the selection of which depended upon the type of surface to be cleaned. Other data obtained concerned the degree of decontamination effectiveness of the various items of equipment, and the manpower, equipment and material required to accomplish the task at hand.

TARGET COMPLEX DECONTAMINATION TEST

The contamination team places the contaminant bearing hopper on the platform where the spreaders will be loaded from the hopper for dispersal on to the lawns, sidewalks, etc.



Sand contaminant being spread on a lawn by manually operated dispersers. The operator must walk at a constant speed to obtain uniform spreading. A radiological safety monitor is measuring radiation exposure rates in the vicinity of the dispersing personnel.



Press and television representatives were invited to both the contamination and decontamination events and a briefing was held to explain the interrelationship between the time to emerge from a shelter after an atomic attack to begin clean-up operations and the intensity of radiation in the surrounding area. Both phases of the experiment received wide publicity, with feature articles, pictures and considerable telecast time. Some thirty members of the Laboratory participated in the field aspect of the project. Reports are being written and preparations are being made for additional tests of this type early in 1960.

Community Fallout Shelter Tests

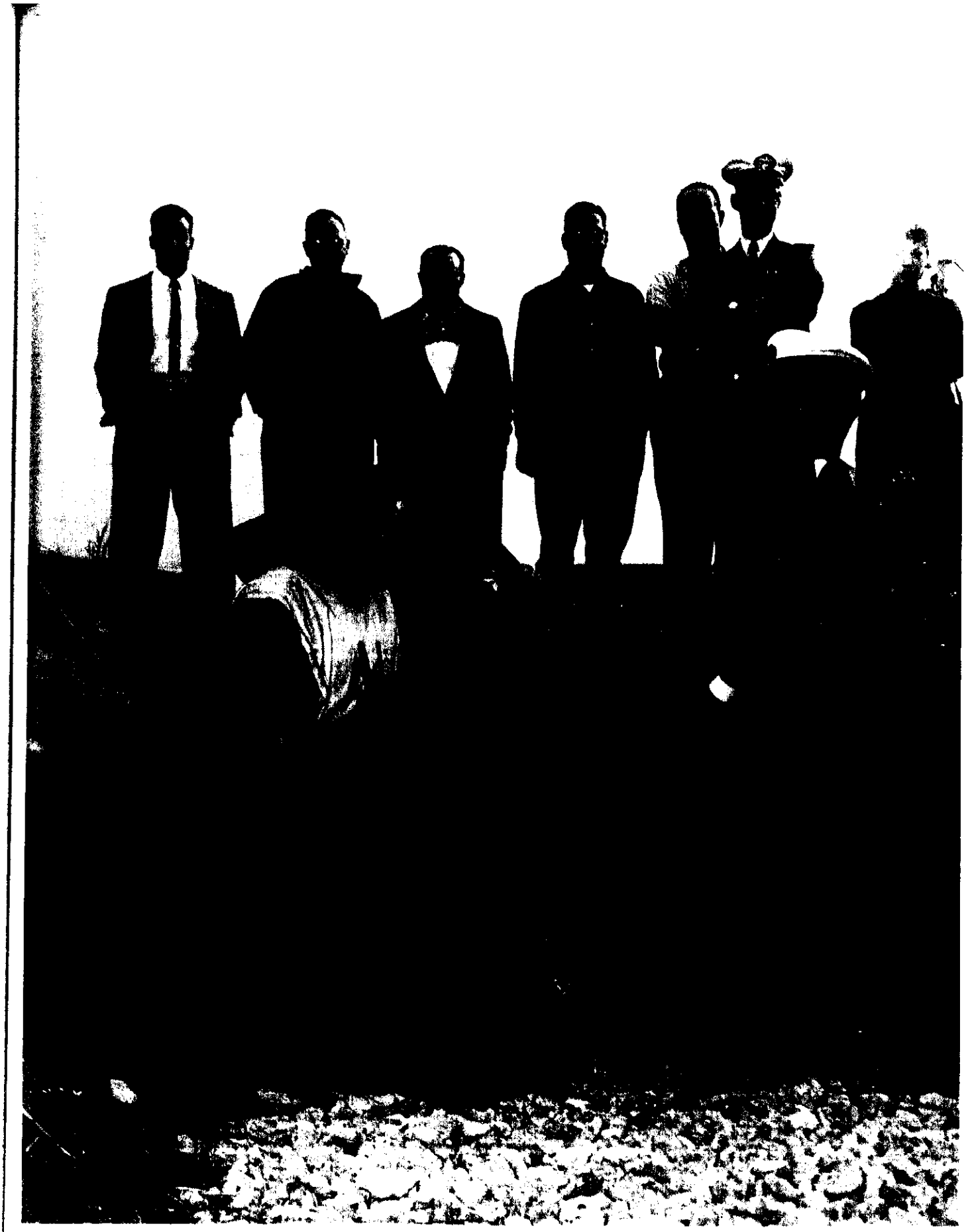
In the course of studies of weapons effects on military installations in the past several years, the Laboratory has devoted increased effort to the study of the effects of a nuclear attack on the Nation. One aspect of this continuing program, which also includes the decontamination experiment just described, is a study of community fallout shelters. Under the sponsorhip of OCDM, such a shelter was designed and developed by the Laboratory. A series of tests was planned, utilizing the shelter. The first of these simulated occupancy of the shelter by the use of heat and vapor sources representing people to determine the resulting temperature, heat and humidity conditions.

On 23 November, a preliminary occupancy test was conducted using seventeen staff members of the Laboratory and OCDM. These personnel remained in the shelter for three days to test organizational arrangements, food preparation, shelter habit patterns, etc., in anticipation of a full scale run.

The experimental shelter is similar to a Quonset hut; it is 25 feet by 48 feet in area; is buried 15 feet below the earth's surface and covered with three more feet of earth. Entrance is through an inclined tube. The shelter is equipped with forced ventilation, a self-contained gasoline-powered generator for power, sanitary facilities, bunks (4 deep) and tables to feed 50 people at a time. It is designed to house 100 persons for a period of two weeks.

A full scale test began on 3 December and lasted for exactly fourteen days. A total of 100 men, composed of 92 prisoners from the nearby Santa Rita Rehabilitation Center (on Alameda County prison farm), five guards from the Center and three members of the Laboratory (the Shelter Commander, his Deputy and a medical doctor) filed down the ladder and the steel door was dogged shut. All were volunteers, privileged to withdraw any time they desired. Not one left by choice, though four had to leave just before the end of the project, two because of illness, and two because of unavoidable and unscheduled court appearances!

End of the full-scale Fallout Shelter Test. The Laboratory Commanding Officer and Director, Captain J. H. McQuilkin opens the door for the bearded Shelter Commander, Mr. Walmer E. Strope. Members of the Laboratory in the background



Shelterees proudly exhibit their Certificates of Appreciation just prior to exodus from "Mole Hole"


SOMETHING

During the entire operation the shelter was kept under constant surveillance by a psychologist and a sociologist by means of closed circuit television. Stationed in a nearby trailer equippped with a 24-inch TV monitor, they were able to observe everything that happened in the shelter and to note the shelterees' reactions to the confinement and boredom of a rather uncomfortable existence. One of the principal goals of the test was to ascertain preferences and feasibility of four different diets. These consisted of (1) peanut bars; (2) a liquid composed of powdered milk, water, dextrose-maltose and corn oil; (3) boiled wheat augmented by spaghetti sauce or chili, cheese and peanut butter crackers, fig newtons; (4) the standard Army "C" rations, a meal of 3,500 calories with two meats, fruit, crackers, powdered drinks, jam and candy.

The men were organized into ten groups of ten, each with a leader who represented them in meetings with the Shelter Commander. All were given free rein to suggest changes in the daily routine. Each man wore a jacket with a large number and letter on it for designation of his section and himself. These symbols facilitated identification of individuals by the command cadre, the observers and the shelterees themselves.

Water consumption was limited, with none available for bathing or shaving, and a careful check was kept on the amount of liquid drunk and eliminated. Other measurements were regularly made on individual weight, body temperature, general health, and on the carbon dioxide, carbon monoxide and noise level in the shelter.

Both of these occupancy experiments stirred enthusiastic interest in the Press, and received extensive newspaper, radio and television coverage throughout the country. Daily bulletins were released by the Shelter Commander with comments by the observers on the hour-to-hour activity, reactions to shelter life, and other pertinent information. Upon completion of the test, Certificates of Appreciation were presented to the shelter occupants by the Laboratory Commanding Officer.

Much valuable information was gleaned from the experiment, including how to build and outfit a shelter at low cost; necessary changes in detail construction; what food was preferred; what supplies were necessary and in what quantities. Most unexpected was the discovery that the experiment could probably have been extended in the number of persons accommodated and the length of stay without serious discomfort.

Plans are underway for the next phase, a firestorm over the shelter, which will take place early in 1960.

Congressional Hearings

Laboratory personnel, headed by the Scientific Director, Dr. Paul C. Tompkins, participated in two series of hearings of the Subcommittee on Radiation of the Joint Congressional Committee on Atomic Energy. In

May the subject was "Fallout from Nuclear Weapons Tests." The June hearings were on "The Biological and Environmental Effects of Nuclear War." The official summary of these hearings gave considerable credit to the Laboratory for the basic data presented and the contribution of staff personnel.

ACHIEVEMENTS IN THE LABORATORY

Ship Shielding Experiments

Experiments in shielding were completed aboard the USS COWPENS (CVL-25) and the USS HOWORTH (DD-592) to measure the modifications of gamma radiation fields from selected sources incident to ship structure. Purpose of the project was to determine potential personnel radiation hazards at stations within the ships for radiation field configurations due to nuclear weapons detonations, and to seek prediction methods for the shielding effectiveness of complex structures. The experiments have obtained the shielding effectiveness factors for the ship against gamma radiation sources of different energies and distribution in space. Two technical reports have been written and others are in preparation.

Bio-Medical Accomplishments

In addition to continuing study in various facets of research in radiation injury, the year of 1959 produced the following new data:

Establishment of a potency of neutrons relative to gamma rays (i.e., relative biological efficiency) for death of large animals at less than half of the previous value provides a sound basis for the hazard evaluation of neutron effects in man.

The study of LD_{50} for a number of large animal species has developed a consistant pattern for large animal lethality which may well be applicable to human populations.

A method has been developed for measurement of bi-directional transport of ions in in vivo gastrointestinal tract segments. This system has been used to measure specific organ response to a number of radiation types.

A long-term study of physiological function after acute and subacute radiation exposure is producing important data on late effects of ionizing radiation. Alterations of cardio-vascular function which are usually characteristic of radiation have been shown at an accelerated rate in irradiated animals.

A combination of special observation chambers, modified anesthesia procedures, and micromanipulator techniques has permitted for the first time the guided insertion of micro-needles into minute blood vessels of the liver.

The Specific-Pathogen Free Rat Colony which was in the stage of development during the past three years, is now fully established and providing animals of this species for all Laboratory work.

Radiological Control Team

During the year the NRDL Plutonium Control (PLUCON) Team was redesignated the Radiological Control (RADCON) Team. This group, first organized in 1957, was originally assigned the task of assisting in the monitoring and recovery operations subsequent to accidents with plutonium bearing weapons. This change not only resulted in a new name but also broadened the scope of the team's mission to include all accidents and incidents involving nuclear weapons, reactors, and fissionable or radioactive materials. Sufficient qualified Laboratory military and civilian personnel were assigned on an additional duty basis to maintain three complete RADCON Teams, with definite responsibilities laid down for both Team and individual members. These include: assistance in radiological monitoring; contamination and waste control; decontamination; information and advice for area commanders regarding recovery of contaminated areas, cost of recovery in terms of time, manpower, money, and anticipated effectiveness; and information to local medical authorities in establishing clinical procedures and in assessment of safe and hazardous areas. The Team must, if previously alerted, be capable of deployment anywhere with equipment within two hours. In an emergency without prior alert, it must be capable of deployment within four hours.

A RADCON Team consists of an Officer-in-Charge and five qualified technical assistants, including specialists in radiological safety, recovery, instruments; a medical officer and a hospital corpsman. Each of these has special duties to perform.

Twice during 1959 the NRDL Team rendered advisory services in solving radiation contamination problems in the West.

Instruments

A field RADIAC developed at NRDL for monitoring alpha radioactivity appears to be the only reliable militarized field instrument for this purpose. It is now in the initial stages of procurement by the Bureau of Ships.

Detailed studies have indicated the feasibility of a tactical simulator that will permit rapid assessment of involvement in a radiological situation. Design contracts were let during this year and construction is planned for 1960.

Great interest has been expressed in the NRDL "Dynamic Fallout Model." A visit by the Army's Command and General Staff College concerned use of information from the model for studies of tactical requirements for and utilization of fallout information. Data computed from this model will also be used as input into the tactical simulator mentioned above.

PUBLICATIONS

Reports and Memoranda

Total number of NRDL reports for 1959 were:

U. S. Naval Radiological Defense Laboratory Reports (Formal)	2
Technical Reports (USNRDL-TR)	84
Technical Memoranda (TM)	17
Progress Reports (P)	6
Instrument Evaluation Reports (IER)	9
Evaluation Reports (ER)	2
Reviews and Lectures (R and L)	20
Total	140

In addition to the NRDL reports, material was supplied for eight technical reports published by the Defense Atomic Support Agency.

Manuals -- Analyses -- Tables

A number of manuals and other publications were completed during 1959. These include two for the Bureau of Ships:

1. "Principles of Radiation and Contamination Control" (PORACC), a 3-volume manual, was completed and submitted to the Bureau for review and for final publication by the Government Printing Office. This publication provides information in three general areas. Volume I, designed principally for the lay audience, deals with a general introduction to the physics of radiation and its biological effects which can endanger health. Techniques are described for measuring radiation and minimizing the chances of personal injury. Volume II is a discussion for those with special responsibility concerning radiation, particularly radiological monitors. Volume III, for technical personnel, provides data needed to conduct training courses.

2. The final draft of "Radiological Recovery of Ships," a chapter of the Bureau's Technical Manual assigned to NRDL, was also completed and submitted for Bureau approval.

A comprehensive analysis of weapons test thermal data was prepared and submitted for pre-publication review by the Defense Atomic Support Agency. This was in compliance with a request by DASA for a collection in one publication of data including all parameters of thermal radiation measured by NRDL from nuclear detonations dating back to 1950.

Composite casualty and damage assessment tables, which for the first time provide a realistic basis for umpiring naval war games involving the effects of nuclear weapons, were prepared. Interim procedures for umpiring single-weapon nuclear attack on naval ships enable assessment of ship damage from air-blast and underwater-shock effects and the assessment of personnel casualties from air-blast, thermal and initial-gamma radiation effects. A tabular format (series of 210 tables) was developed allowing the umpire to directly assess ship damage and combat ineffectives from air and surface bursts and ship damage from underwater bursts. This was a short-term study of limited scope. A current Casualty Assessment Problem extends the scope of the interim study to include all significant operational factors including the non-circular effects of transit and deposit ionizing radiation.

The Scientific Director wrote the Chapter on "Surface Contamination and Decontamination" for the HANDBOOK ON RADIATION HYGIENE, published by McGraw-Hill.

Miscellaneous Publication

Other Laboratory publications issued during 1959 include:

1. An internal instruction on radiological safety in the Laboratory's work operation.

2. A revised budgeting and cost reporting plan.

3. A combined personnel handbook and document kit for Laboratory personnel.

4. Cost accounting and procurement services manuals.

5. The twelve-year (1946 - 1958) Command History of NRDL.

Publication in the Open Literature

Scientists of NRDL have had 52 papers and articles published in such journals as: Radiology, Analytical Chemistry, American Journal of Physiology, Radiation Research, Mechanical Engineering, Physical Review, Science, American Journal of Roentgenology, Nature, American Journal of Industrial Hygiene, Journal of Chemical Physics, British Journal of Radiology, Yale University Press, American Medical Association Journal, Federation of American Societies for Experimental Biology Proceedings, Transplantation Bulletin, Nuclear Instruments, Archives of Biochemistry and Biophysics, Nuclear Physics, Inorganic and Nuclear Chemistry, Journal of Chromatography, Journal of Nuclear Science and Engineering, Annals of the New York Academy of Science, International Journal of Applied Radiation and Isotopes, Human Biology, Journal of Immunology, Journal of Biological Chemistry, American Geophysical Institute, Bureau of Ships Journal, Journal of Optical Society and Journal of the National Cancer Institute.

Patents

Two patents were issued to NRDL scientists, one for a method and apparatus to control the wear of brick linings in steel melting furnaces; the other for a device to transmit the output from a capacitative transducer to a remote location where the output is recorded by conventional means.

ORGANIZATION

With a few exceptions, the internal organization of NRDL remained unchanged. Three branches in the Scientific Department were created to replace three others which were disestablished. The Radiation Characteristics and Effects Branch and the Radiological Physics Branch resulted from the amalgamation of the Nuclear Radiation and Thermal Radiation Branches of the Nucelonics Division. In the Chemical Technology Division, the Radiation Chemistry Branch developed from the group formerly termed the Applied Research Branch. A bio-assay program was also inaugurated within the Radiological Health Division, the personnel being drawn from the Chemical Technology Division.

Personnel changes in key positions were also limited. CAPT Albert R. Behnke (MC) USN retired from the Navy. He was relieved as Radiological Medical Director by CAPT Harry S. Etter (MC) USN. CDR Robert J. Connolly relieved CDR Jack A. LaSpada (who also retired from the Navy) as Technical Services Director. CDR Randolph W. King relieved CDR Donald C. Campbell as Senior Program Officer. The new Radiological Health Officer is LT David Katz, relieving LT Walter L. Taylor who is devoting his time to investigations in the Biological and Medical Sciences Division. LT Robert E. Thompson relieved LCDR Joseph S. Kelly as Head, Military Personnel Division. The only changes in the roster of key civilians were the appointment of Dr. Edward L. Alpen as Head, Biological and Medical Sciences Division, and the resignation of Miss Marion Sandomire as Statistical Consultant to the Scientific Director, which position is not as yet filled.

FACILITIES AND EQUIPMENT ACQUIRED

Settling tanks to hold Laboratory liquid waste pending monitoring were completed.

A low background room was designed and construction started. This room will have 6-inch thick walls, floor and ceiling, and will be used to study and detect low level radiations.

Design for the tactical events simulator was begun. This will be a 20 foot by 60 foot model wherein simulated nuclear weapons effects as functions of time and space can be dynamically superimposed on mobile targets.